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Forerunner of Progress in Mining, Quarrying, Construction

One of North America's outstanding underground mining operations is at Climax, Lake County, Colorado, 100 miles southwest of Denver. There, on one sloping side of 13,863-ft.-high Bartlett Mountain, 20 ft. below timber line, Climax Molybdenum Company mines molybdenum, one of the world's most vital metals.

Climax is big and progressive. Of its 1,400 employes, 625 work underground. Mining is conducted on two levels: the Phillipson, at an elevation of 11,465 ft., and the Storke, at 11,168 ft.

Climax refers to its system of mining as "progressive caving," which includes three major factors: the slusher drift, the finger raise, and the stope-and-pillar undercut.

Mining operations require the use of more than 2,000,000 lb. of explosives a year. The current annual production rate of molybdenum concentrate is 42,500,000 lb., well over half the output of the United States.

In a comprehensive article beginning on page 71, the author, Lewis Nordyke, describes some of the more significant operating details on the Storke level, and presents a picture of the beautiful company-owned community.

• • •

In 1870, Joseph Jefferson, world-famous actor and artist, purchased a knob of land rising out of the flat coastal plain of Louisiana and built a mansion. Persistent efforts to find a source of fresh water under the land yielded only salt water. Today, on this same tract of land, salt is being mined 1,000 ft. under the surface by Jefferson Island Salt Company. This underground cigar-shaped tower of salt yields a mine-run product better than 99 per cent pure.

In the article beginning on page 84, Don Macon summarizes the company's room-and-pillar mining operations in which working faces are 24 ft. by 70 ft. Primary blasts of 500 lb. of Hercomite® 2-X loaded into 128 drill holes produce an average of 850 tons of salt per blast.

• • •

On a highway construction job in New Hampshire, the contractor, U. O. MacDonald, used 9-in. well-drill holes and Gelamite® dynamite to blast a hill of granite 63 ft. deep, 125 ft. wide, and 1,200 ft. long, without benching. It marked the first time this size drill hole was ever used on this kind of work in the state. Results were particularly gratifying.

A brief resumé of Mr. MacDonald's drilling and blasting methods is included in the article on page 88.

• • •

The removal by blasting of a 12,000-cu. yd. solid ledge of rock in the forebay area of an existing 550,000-hp. generating station in Canada, with the location of the structure only 85 yd. away from the rock, posed a difficult problem. After a series of tests, the solution to the problem proved to be the placing of a curtain of compressed-air bubbles in the water. The air curtain absorbed the shock waves from the blast and no damage was done.

For more details, please turn to page 91.

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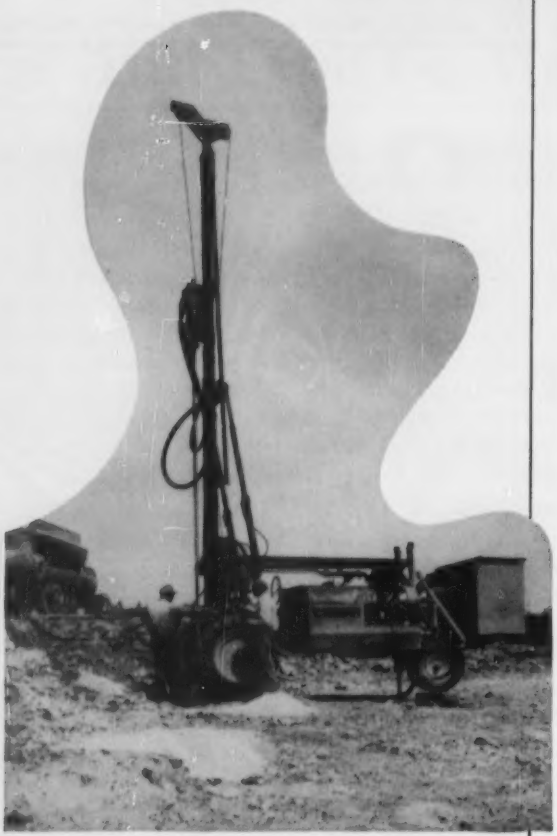

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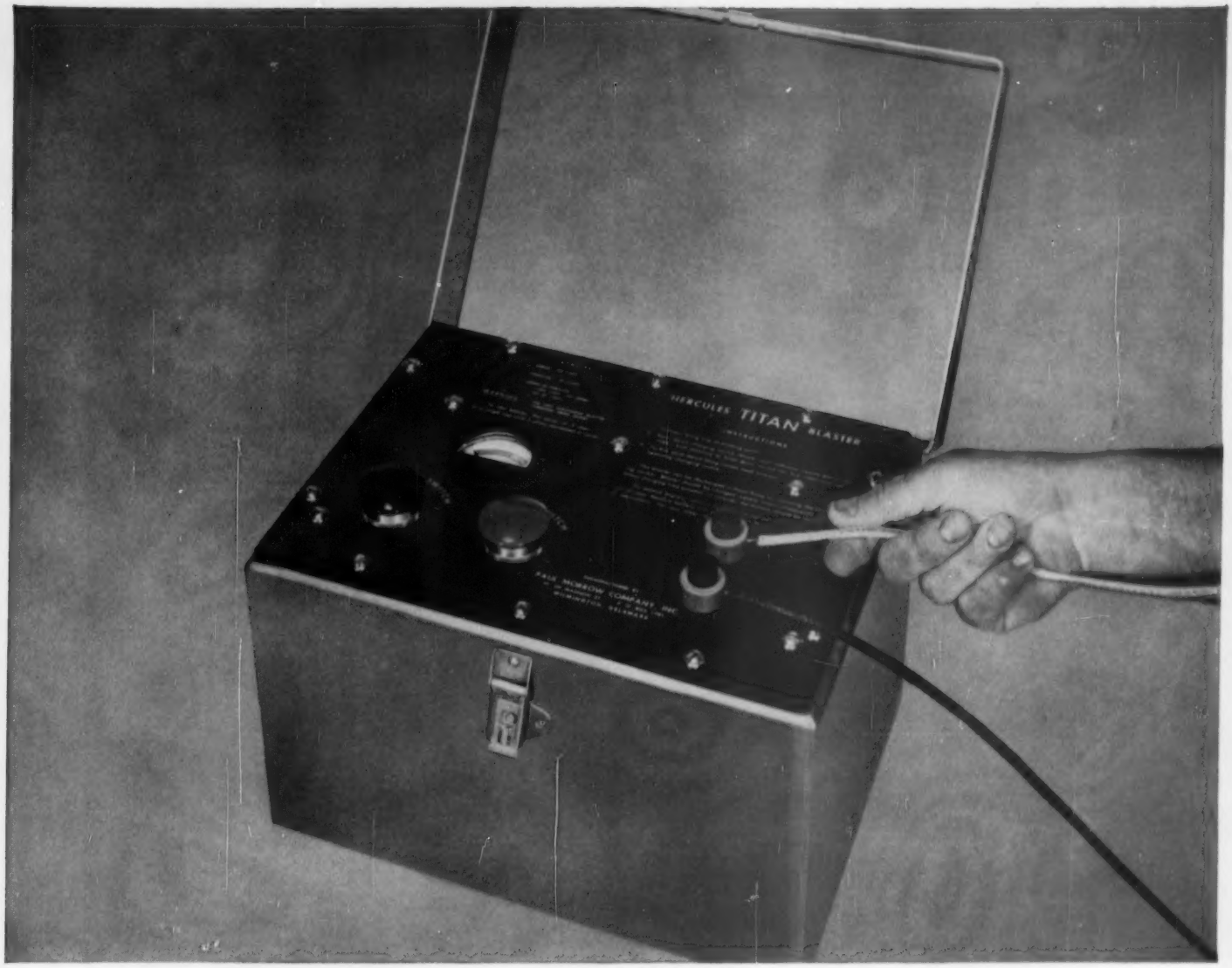

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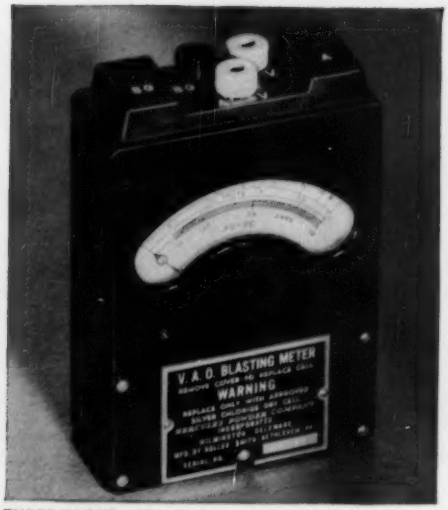

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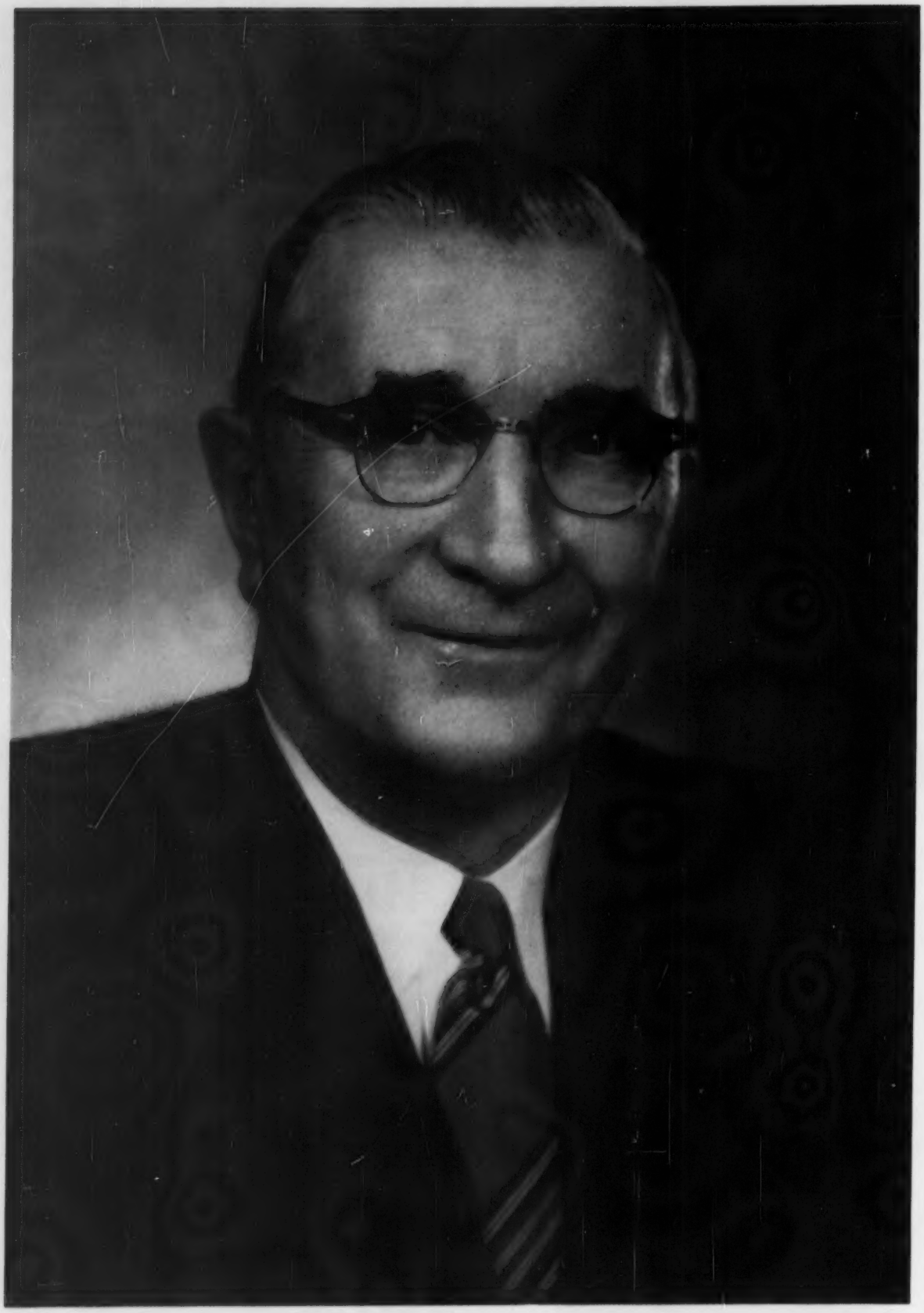


JOHN MacLEOD

John MacLeod

PRESIDENT AND CHAIRMAN OF
THE BOARD OF DIRECTORS
MACCO CORPORATION

A Biography

FOR MANY YEARS, John MacLeod, president and chairman of the board of directors of Macco Corporation, and president and director of Pacific Dredging Company (a Macco affiliate), has been a builder of many and varied types of structures and facilities. But, most importantly, he has built for himself a happy, successful, and useful life. Today, this onetime immigrant carpenter has the respect and admiration of his contemporaries in the construction industry the world over.

John, as his friends and associates know him, was born in Invernesshire, Scotland, February 12, 1894, the son of Malcolm and Janet MacLeod.

Following his graduation from Queens Park High School in Glasgow, at the age of seventeen, John moved to Canada and took a job as a construction carpenter for the firm of Walter Hipburn Company. Later, he was foreman of carpenters for Bates & Rogers Construction Corporation on the building of the Grand Trunk Pacific Railroad in western British Columbia. Subsequently, he became general superintendent in the Tie and Timber Department of the Canadian Pacific Railroad.

In 1923, John came to the United States and went to work as superintendent for William Simpson Construction Company. Six years later, he formed Macco Construction Company; later, the name was changed to Macco Corporation. The new firm was organized primarily to build derricks and other facilities for oil companies in California.

Within a few years, Macco Corporation branched out into the general construction-engineering field. Its first big contract award was for the construction of San Gabriel Dam No. 2. Since that time, Macco has completed many major construction projects in the western part of the United States, in Alaska, Canada, the Aleutian Islands, and in the Pacific Islands. The total value of work completed by the corporation and its subsidiaries approximates $600 million.

One of Macco Corporation's biggest customers is the United States Armed Forces. During World War II, it was the first Western construction organization to be awarded an Army and Navy "E," for completing the United States Navy Fuel Supply Depot at San Diego ahead of schedule and below the estimated cost. Another first for Macco among Western construction contractors was a second Army and Navy "E" award for duplicating this accomplishment in the construction of the Amphibious Force Facilities at the San Diego Destroyer Base.

The operations of Macco Corporation are conducted by seven divisions: Construction, Refinery and Chemical, Rig Building, Drilling Fluid, Pipeline, Lumber, and Crane and Rigging. Macco owns 50 per cent of Pacific Dredging Company. This company has completed many large projects on the Pacific Coast of the United States, in Canada, and in the Orient. It is the sole owner of Diversified Builders, Inc., specialists in building and industrial development. During the past twelve years, more than 200 contracts valued at $200 million have been completed.

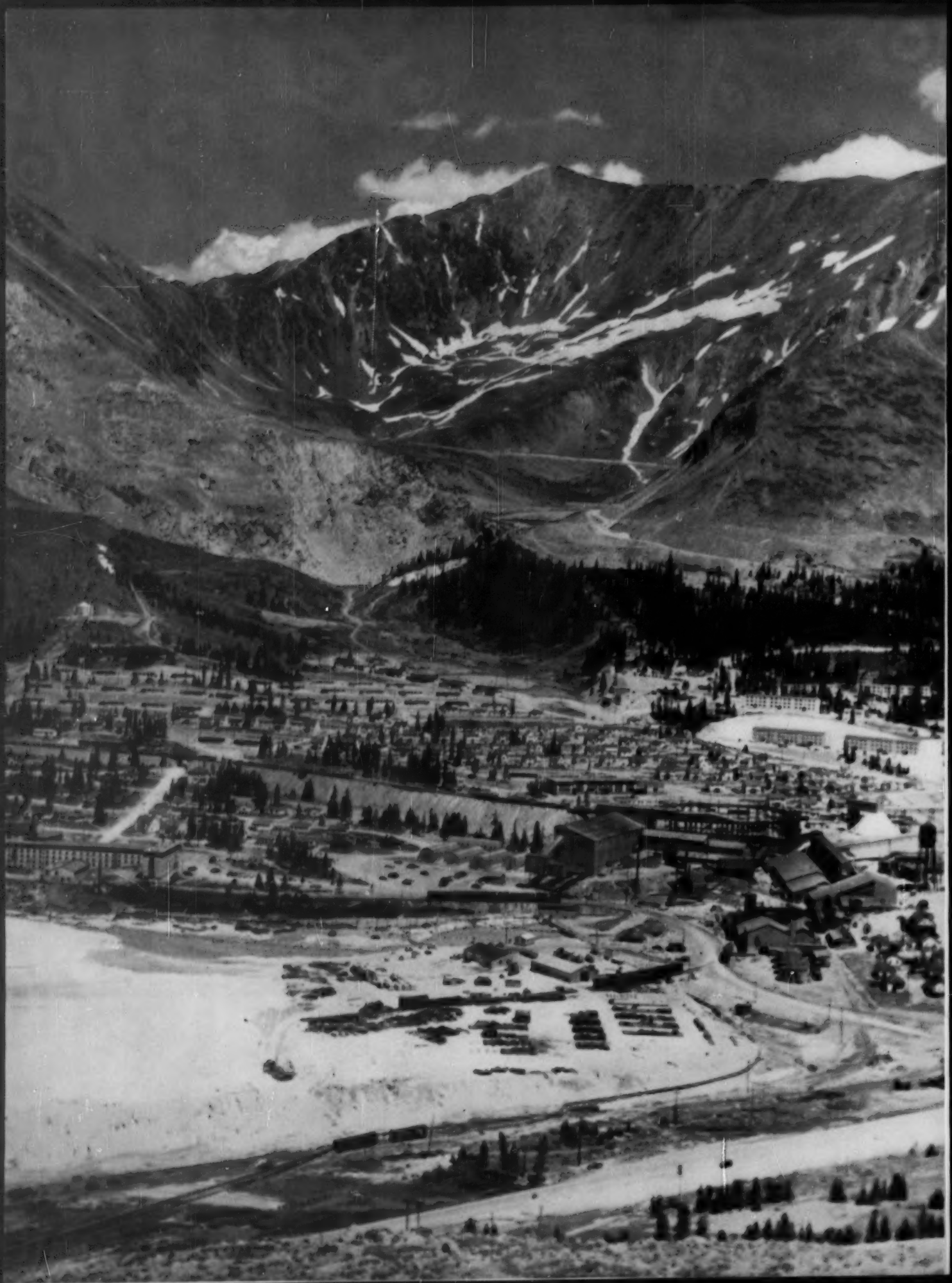
With Macco's recent acquisition of Pacific Crane and Rigging Company, it now operates the world's largest company in the crane and rigging field.

Although the far-flung operations of Macco Corporation and its subsidiaries have demanded, and still demand, most of John MacLeod's time, he has demonstrated keen interest in legislation as it affects the construction industry. Much of his time has been devoted to the Associated General Contractors of America: he was president of the Southern California Chapter in 1941; then a director of the National AGC; a vice president of the National Association in 1953; and its president in 1954. Currently, his activities in AGC include membership of the National Executive Committee, and chairman of the National Finance Committee. He is also a member of the Accident Prevention Endowment Fund Committee, Progress Committee, and Joint Cooperative Committee with the Surety Association of America.

John MacLeod married Elizabeth Clark on October 15, 1927, in Los Angeles, California. They have three children: Mrs. William Shattuck (Kathryn); Mrs. John Klug (Janet); Jacque, a senior at University of Southern California; and two grandchildren. The family home is at 20 Harbor Island, Newport Beach, California.

Mr. MacLeod's club affiliations include Jonathan, Wilshire Country, Nineteeners, Beavers, Shriners, and Newport Beach Yacht Club.

Despite the heavy demands of his complex duties and responsibilities, this unassuming, friendly man's office door is always open to welcome friends, fellow officers, and employes. When he can indulge his hobbies, John finds relaxation in horseracing, golfing, sailing, and fishing.



CLIMAX MOLYBDENUM ON THE CONTINENTAL DIVIDE

With the development of a "progressive caving" method of mining and the use of more than 2,000,000 pounds of dynamite annually, Climax Molybdenum Company has produced 42,500,000 pounds of molybdenum concentrate a year

LEWIS NORDYKE*

ONE of North America's outstanding underground mining operations is at Climax, Colorado, 100 miles southwest of Denver. There on top of the Continental Divide the hard-rock innards of sky-piercing Bartlett Mountain are being mined by the caving method, at two separate levels, for the production of one of the world's most vital metals – molybdenum. The ancient Greeks knew of it and had a word for it, "leadlike," but they had no idea that the gray substance could ever become so essential to mankind.

Molybdenum, which for the convenience of spelling is familiarly known as "moly," is the stuff that makes steel tough enough to withstand the speed, stress, and heat of the atomic age. On a recent visit to Climax, V. L. Mattson, director of the Colorado School of Mines Research Foundation, remarked: "It would be impossible for this country to fight a major war successfully without moly steel and moly lubricant."

Either by whimsey or by purpose, the force that pushed up mountains eons ago deposited a large portion of the world's known economic reserve of moly in a doughnut-shaped orebody in the granite recesses of Colorado's 13,863-ft.-high Bartlett Mountain. Imaginative Jonathan Swift never sent his adventurous hero, Gulliver, into a more fantastic land than the mountain-top valley of Climax, 11,320 ft. up in the blue, just 20 ft. below timber line.

It is a fabulous project in every way, particularly in the blasting of the moly ore. The mining operation is a type of caving, for the miners are actually caving in the mountain, and the surface is sinking as the insides of the peak grind down through finger raises into the slusher drifts. Despite the strategic value of molybdenum, the low-percentage ore could not be profitably mined by other underground methods.

Big and Progressive

The mining concern – Climax Molybdenum Company – is one of the most progressive operators in the country. It recently completed a $34,000,000 expansion program which, among other things, boosted mill capacity 75 per cent and the end product 78 per cent. The mine gives up 28,000 tons of ore daily. The operation requires more than 2,000,000 lb. of explosives a year and at least 70,000 tons of concrete. The annual work details add up about like this: stoping, 170,000 sq. ft.; raising, 2,800 ft.; drifting, 9,300 ft.; vent raising, 2,350 ft.; vent drifting, 1,170 ft.; diamond drilling, 7,500 ft.; air circulation, 300,000 cu. ft. a min. Water consumption by the mine and the community totals about 14,000,000 gallons a day.

Climax is big and progressive. It has 1,400 employes, with 625 of them working underground. It can be said without exaggeration that Climax is an exemplary operation, and it has a nice portion of human warmth and understanding. For example, it respects without a word the occupational rule of hard-rock miners that no woman may enter the portals of the mine. Anything lovely who might show up from Hollywood, or the Land of Sheba, must stop at the entrance of either the Storke or the Phillipson level of the Moly Mountain Mine.

Beautiful Alpine Community

The company has much more to do than mining and processing moly. It owns the beautiful alpine community of homes, even to the schoolhouse; it supplies the water for the homes, and television towers that capture the TV signals out of thin air and route them to the comfortable residences of employes. The company faces up to the human problems that are peculiar to the wonderland known as Moly Mountain.

To quite an extent, the town of Climax has always been fantastic. It is high and cold, with an annual average snowfall of about 23 ft. When excavation for plant improvement is necessary in the long wintertime, it takes three days of wood-burning on the ground to thaw it sufficiently for pouring concrete foundations.

In the early days of rich-strike mining, when booming Leadville was the glittering Baghdad of the Rockies,

*2809 Lipscomb Street
Amarillo, Texas

TWO SURFACE OPERATIONS: In this view of Climax from an airplane, the surface operation of the Storke level is seen in the foreground while the Phillipson level works are shown in the background.

Bartlett Mountain was considered bleak and barren. Men had their hearts and heads set on gold and silver, and a show of moly in a prospector hole brought no glint to the hopeful eye, so they missed the richest treasure of all, though it loomed a hulking giant in the sky.

In the first part of the 1880's, John Evans built his Denver, South Park & Pacific Railroad over the highland humps to Leadville. It crossed the Continental Divide at Fremont Pass almost within the shadow of Bartlett Mountain. Lore of the Rockies has it that when the construction gang reached the top of the pass on the long upward slope from Dillon, the foreman announced: "We've hit the climax!"

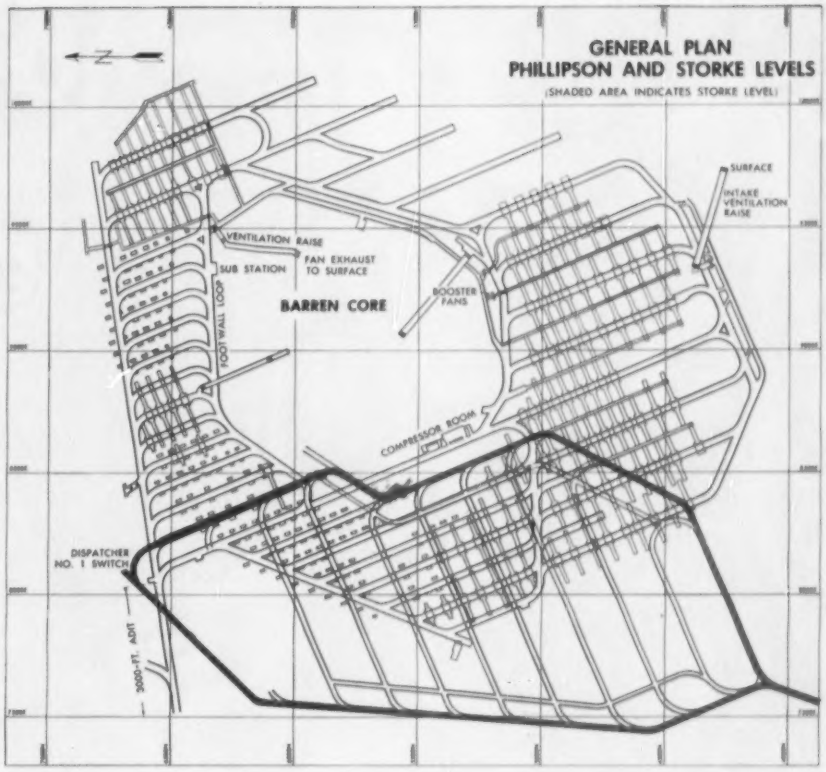
That is the way the community received its name. However, the real climax was in the future. Within half a century, bleak old Bartlett was recognized as the real bonanza; the value of its output is comparable to that of all other mines in Colorado.

First Claim Staked in 1879

A prospector named Charles Senter started what became the "Miracle of Moly Mountain." He staked the first claim on Bartlett on an August day in 1879. Shortly after the turn of the century, he sold the claim to Otis King, who was the pioneer in the development of the mountain and the metal. Mining was under way by 1912, but it was not until 1918 that Climax produced molybdenite concentrates. The importance of moly became recognized during World War I, and production was stepped up. But late in 1918 the mine shut down. The company's stock tumbled to an all-time low, with few buyers. Those who did buy struck it rich. By the middle 1920's, research showed that moly steel had a great potential in the manufacture of American automobiles. The mine went back into production in 1924 and has operated continuously since. However, the real rise of moly didn't come until military machines took on the World War II look. During the war the demand for moly was far ahead of the supply. When the atomic age dawned, moly became strategic to national defense, perhaps second only to uranium. Climax Molybdenum Company, which produces the bulk of

the nation's supply, rose to the occasion. In the middle-1920's, the daily production of ore was 300 tons. This jumped to 6,500 tons in 1935, to 20,000 in 1943, and now it is up to 28,000 tons. Up until 1948, all the moly ore at Climax was taken from the Phillipson level and levels above. During the next four years, a small tonnage of ore was mined in the deeper Storke level. In 1952, the Storke level was put into full operation, with production continuing on the Phillipson level.

Only expert engineering and the near-perfect development of caving could have stepped up production by such staggering proportions. There has been as much research in the technique of caving as there has in the uses of molybdenum. There is nothing hidebound about Climax. The company is known as a progressive organization, one which never turns a deaf ear to a new idea. It likes to experiment and develop, the idea being more production at less cost and with greater safety and fuller recovery of metal-bearing ore. In this, the management and the operating team have been successful.



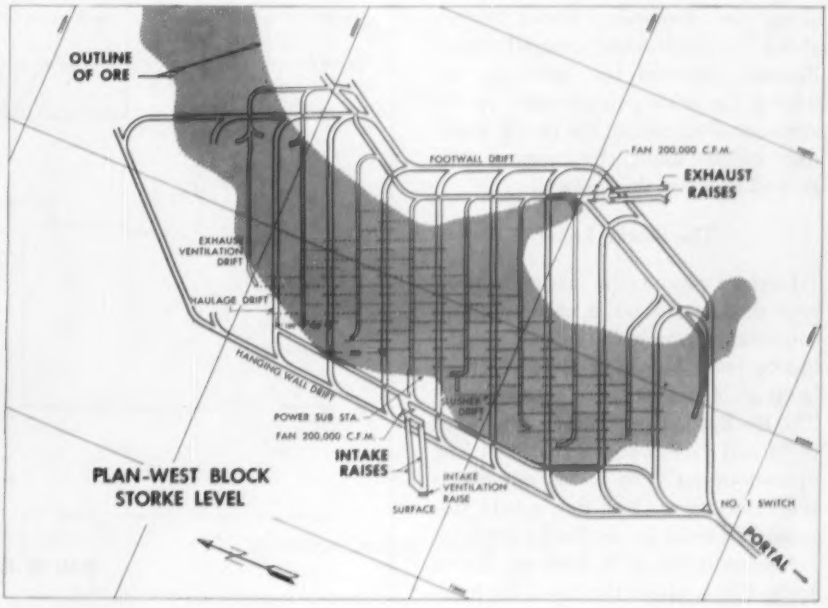
Progressive Caving

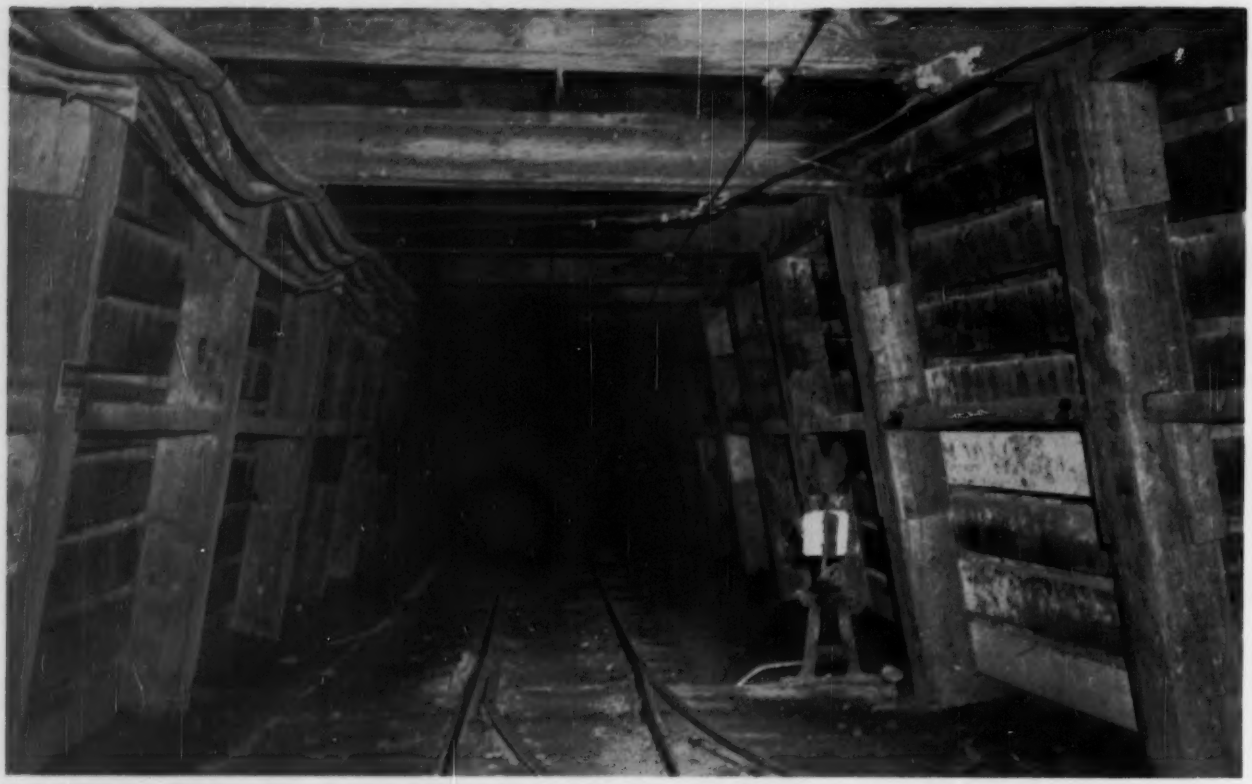
Over the years the method of caving has been revolutionized in the Climax mine. After World War II, production dropped off, and in this slack time, Climax continued its research and came up with new ideas on how best to mine a mountain by the caving method.

Block caving has been widely used since the last years of the nineteenth century. It was initiated at the Pewabic Mine on the Menominee Range in Michigan. At Climax, the system is an improvement of the block method, and Climax refers to it as "progressive caving." This system includes three major factors: the slusher drift, the finger raise, and the stope-and-pillar undercut. The slusher drift is the key. Slusher drifts and fingers are concreted heavily, not for support but to prevent the raveling of the fractured rock induced by concussion from blasting and the pounding of the rock as it moves down through the fingers. The concreting also reduces the wear caused by the gouging action of the scraper on the ribs of the drift.

Climax has made a thoughtful study of the geology and the principles of caving. Its planning and production are based on the findings derived from this study. The orebody lies within the pre-Cambrian granites and schists, in a rock type known as Climax (early) porphyry. The age of mineralization is considered early tertiary. The productive portion of the ore surrounds a highly silicious core, and the ore varies in thickness from 250 to 400 ft. The mineralization is characterized by fracture filling and replacement through silicification. The main mineral is molybdenite.

The first methods were shrinkage stoping with 25-ft. rooms and 25-ft. pil-





PORTAL OF STORKE LEVEL: *This is the portal of the Storke level where full production began in 1952. Operating details described in this article are confined to the activities on the Storke level.*

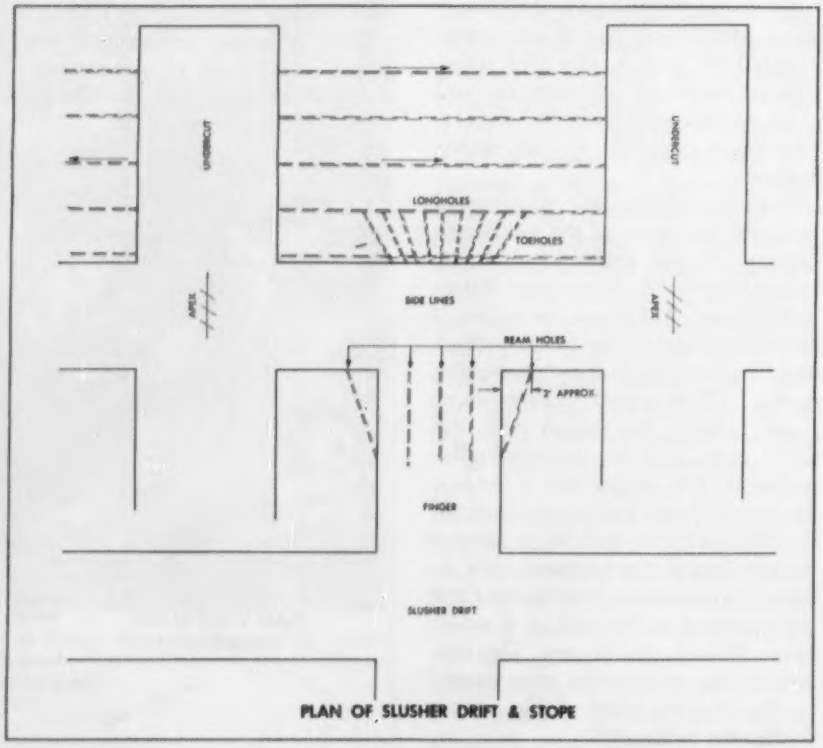
lars, and glory hole mining. These were carried on at an old level known as the Leal. Later on, shrinkage stoping with 50-ft. stopes and 40-ft. pillars was used at the White level. Induced block caving was the first method used on the Phillipson level.

Up to 1945, cutoffs were used only along the footwall. Shrink stopes about 7 ft. wide were generally used. Research showed the need for reducing the draw point spacing in the stopes and increasing the use of boundary cutoffs along the hanging wall as well as along the footwall.

The Storke Level

Current production, with the new-type slusher method, is on the Phillipson level, elevation 11,465 ft., and the Storke level, elevation 11,168 ft. The haulage drifts are on these levels. The Phillipson has 29,300 ft. of haulage drifts and the Storke has 18,950 ft. The operations on both levels are essentially the same, but this article discusses the work on the Storke level.

Slusher drifts 10 ft. high are driven immediately above the cap of the haul-



PLAN OF SLUSHER DRIFT & STOPE

age drifts and at right angles to them. The standard slusher drift is 112 ft. long; when concreted, it is 7 ft. wide and 9 ft. high. In general, the slusher drifts are 34 ft. apart, running at 90 degrees to the haulage drift, alternating to the left and right from the draw hole at the centerline of the haulage drift.

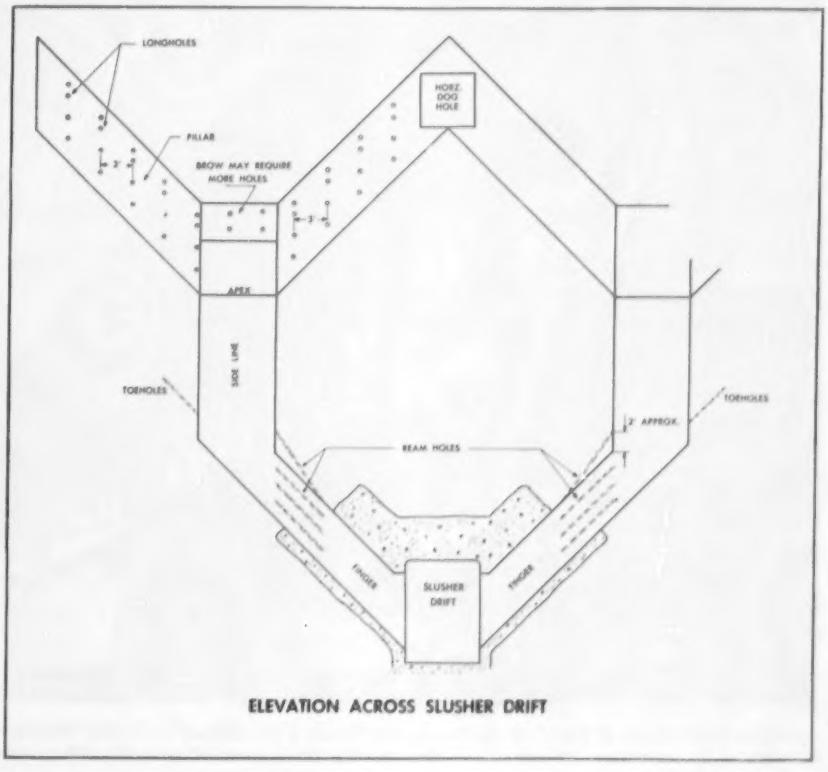
The finger raises, 8 ft. wide and 4 ft. high, are driven from the bottom of the slusher drift on a 45-degree upward angle. There are six fingers to the standard slusher drift, each 32 ft. apart. From the top of the finger, the undercut is driven on a muck slope, 45 degrees, 37 ft. from the center of the slusher drift. There it turns 90 degrees left and right, in horizontal direction, and is driven 12½ ft., still on a 45-degree slope. Then it is turned 90 degrees again back toward the slusher drift. Here it is driven on a 45-degree slope until it is over the center of the slusher drift, where it connects with the undercut from an adjoining finger. The resulting stope contains alternate undercut and pillar, both inclined. When the pillars are long-holed and blasted, the weight that God put in granite mashes down and the innards of the mountain come rumbling down with the sound of a distant earthquake, the ore breaking and grinding somewhat as it caves. It pours down the fingers like grain scooting out of a bin spout and spills into the slusher drift. The area of the undercut of a standard slusher drift is 6,800 sq. ft.

However, before the blasting of the pillars and the resultant caving are accomplished, something else must be done. As soon as the slusher drift and fingers are driven they are lined with concrete at least 1 ft. thick. Steel and wooden forms are used. The concrete is mixed underground. It is given 28 days in which to set before the longhole blasting is done. However, stoping continues while the concreting is in progress.

Drilling

Each operation preparatory to the caving requires its own type of drilling and blasting. In driving drifts and stopes, the blast holes in a round are 7 to 8 ft. deep; the long holes in pillars are 24 ft. deep. Holes in the burn cut average 2 to 3 in. apart. Reliever holes

LOADING OUT THE ORE: After ore has been dropped by gravity into a slusher drift, it is pulled by a 6-ft. by 36-in. folding steel scraper to "draw holes" located directly above 10-ton-capacity mine cars. Loaded cars are hauled to the crusher in 25-car trains.



ELEVATION ACROSS SLUSHER DRIFT

are about 1 ft. from the burn. All other holes are placed at the miner's discretion, about 1½ to 3 ft. from the reliever holes.

As a rule, Leyner drills are used in driving slusher and haulage drifts. Target advance each day is 8 ft. Stopers are used in the finger raises and in the undercut and sideline. Jacklegs are used in vent drifts.

Small drills, such as jacklegs and lightweight stopers, start and bottom with a 1⅝-in. bit. The use of tungsten carbide bits makes this possible. Small drills are classed as 2⅝-in. bore, using about 110 cu. ft. of air a min. Medium drills are 3-in. bore with an air consumption of 170 cu. ft. a min. They start and bottom with a 1⅞-in. bit. Large drills are 3½-in. bore, with air consumption of 195 cu. ft. a min.; they start and bottom with a 2⅜-in. bit.

The small drills use ⅞-in. hex. hollow drill steel, starting with a 2-ft. length and ending with 8 to 10 ft. in 2-ft. changes. The steel is 52100 plus molybdenum. Medium drills use 1-in. quarter octagon steel, with a 30-in. starter. No. 2 is 48 in.; No. 3 is 66 in.; No. 4 is 84 in.; and No. 5 is 102 in. The large drills use 1¼-in. round steel when the machines are on jumbos, with 4-ft. starters and 8-ft. seconds. When long-holing pillars, the large drills are equipped with 1-in. round steel in 4-ft. changes.

For this work, Climax uses, on the average, eighty-six I-R R58 stopehammers; three I-R R48 stopehammers; six Gardner-Denver RB94 stopehammers; thirty-one I-R DB35 drifters; twenty-eight Gardner-Denver CF93 drifters; seventeen Cleveland H10 jacklegs; nine I-R JR38 jacklegs; and nine I-R J40 Jackhamers.

COVERED CONVEYOR BELT: From the crusher the ore is transported on a 60-in. conveyor belt to bins 46 ft. high and 100 ft. wide at the bottom. The travel speed of the belt is 350 ft. a minute.

Jet sprays of water keep down the dust. There is no explosive dust in the mine.

Air comes from the central compression room. Compressors include five Ingersoll-Rand units. Two of them have a capacity of 5,000 cu. ft. a min.; one produces 5,400 cu. ft. a min.; one has a capacity of 3,400; and the fifth produces 3,000 cu. ft. a min. One Joy compressor has a capacity of 1,400 cu. ft. a min.; and one J-G XRB type produces 850 cu. ft. a min.

Primary Blasting

In driving drifts and crosscuts, blasting is done with Gelamite® 2 in 1¼ by 24-in. "King-Size" cartridges. For blasting in pillars, 1½ by 24-in. cartridges are used. In stope development, such as raises and subdrifts, 1¼ by 24-in. cartridges make up the charges. No stemming is used. The policy at Climax is to load all blast holes heavily with cartridges of dynamite, especially the burn cut holes. The mine uses well over 2,000,000 lb. of explosives each year.

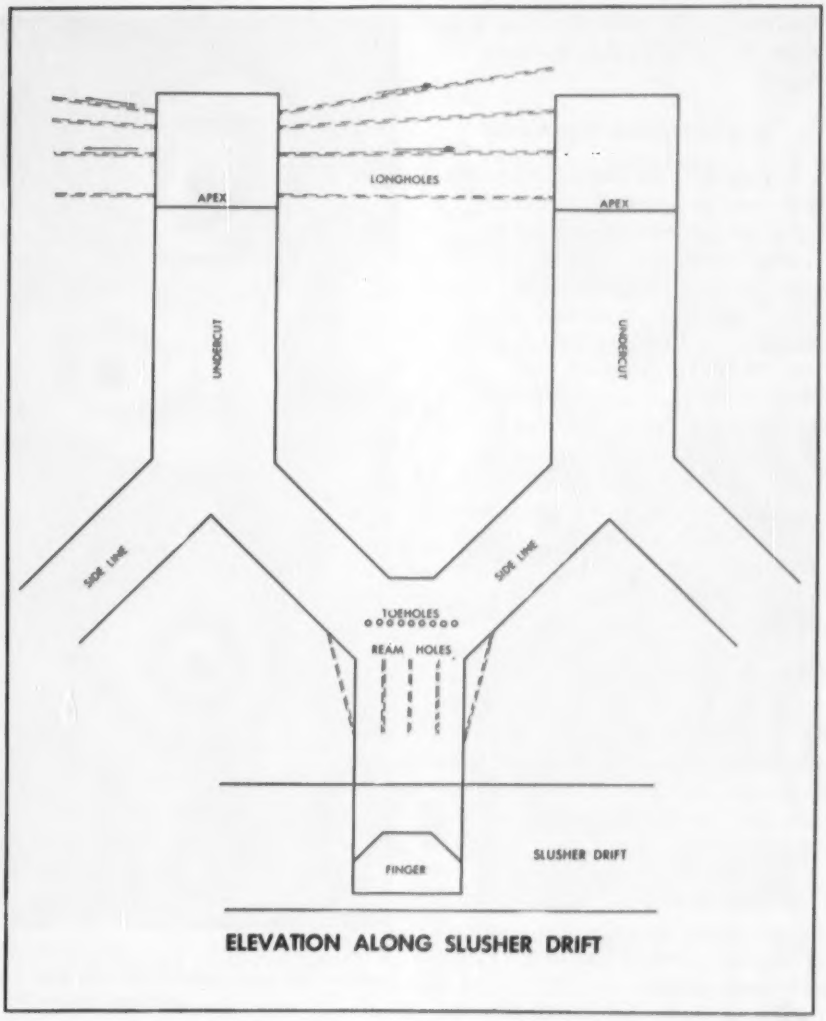
In the driving of drifts, regular and short-period delay electric blasting caps are used to detonate the dynamite charges. Regular delay caps are normally used in stoping, and short-period delays in the pillars. The short-period delay caps include delay periods from 0 to 18, and regular delay electric caps from 0 to 10. The leg wires of the caps in loaded holes are connected in series and blasts are fired with a blasting switch. Results are uniformly satisfactory.

Secondary Blasting

Most of the secondary blasting done is to dislodge and break hang-ups in the cave and the fingers. Caving grinds and breaks the ore. Occasionally huge chunks rumble down and block the cave or fingers. This is something like a log jam in a river. When this happens, a hang-up man climbs through the finger with "hot bundles" – dynamite bombs approximately the size of a man's head. The explosives are attached to a wooden stick, usually 18 ft. long. The explosives are poked under the offending boulders and connected with Primacord* and detonated by the blasting cap-and-fuse method. In some of the accessible places, the mud-capping method of blasting is used. More explosives – bag powder – is used in breaking loose the hang-ups than in the other operations in the mine.

One of the problems of caving is that of keeping an even flow, or draw, of ore from each finger, thus keeping the weight distributed.

When the pillars are blasted and the caving starts, the ore pours into the slusher drift. A 150-hp. slusher hoist, which works like a drag line, pulls the ore to a draw hole – sometimes in 10-ton bites. The slusher drift is equipped with Skookum No. 180 tail sheave blocks. The 1¼-in. wire rope has an ultimate strength of 113,100 lb. The ore spills through the draw hole into the mine car spotted directly below in the haulage drift. The time required to load a car is consistently less than 2



ELEVATION ALONG SLUSHER DRIFT

DRILLING IN A SLUSHER DRIFT: In driving slusher and haulage drifts at Climax, miners generally use Leyner drills to drill blast holes 7 to 8 ft. deep. Blasting is done with "King-Size" cartridges of Gelamite 2.

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company

minutes. As the hoist clears the drift, more ore comes sliding down the fingers.

Equipment and Ventilation

For slusher and mucking work, Climax uses a tremendous amount of equipment, including: five Joy RT 222 tandem hoists with 150-hp. Westinghouse motors; nine Joy 211 (air) hoists with 5 hp.; eight Sullivan J 211 with 15-hp. GE motors; ten I-R 30 ML-3D with 30-hp. GE; thirteen Vulcan DSP 50 with 50 hp.; one I-R 3-drum 50 MNM4D with 50 hp.; fourteen Joy CF 211 with 60 hp.; one Sullivan RT 221 with 100 hp.; forty-three Joy XT 221 (tandem), 150-hp. Westinghouse; thirteen Vulcan (tandem), 150-hp. Westinghouse; sixty-eight Vulcan double-drum (tandem), 150-hp. Westinghouse; one I-R Canadian SS-5 double-drum, 125-hp. GE; twenty I-R D6U, 61 BU, 7 EUL, and 7 HUL tuggers; eighty-one AW 80 Joy tuggers; three Eimco 40 air-mucking machines; one Eimco 40 electric mucker; one Eimco 21 and three 12B air muckers; and one Conway 75 electric mucking machine.

Ventilation is provided by a tremendous flow of air, which in a day weighs more than the ore produced. The vent system is also used to regulate temperature.

The ore is hauled out in 20 to 25-car trains, each car with an approximate capacity of 10 tons. They are Lakeshore and Card Granby-type cars. They unload into the crusher. The car cleaner at the dump block was designed by Climax and made by C. S. Card Company.

The locomotive equipment includes three 4-ton Whitcombs; four 1½-ton trammers (three GE and one Atlas); seven 20-ton GE; eleven 19-ton Atlas; one 13-ton GE; two 10-ton Goodman; one 13-ton Goodman; one 4-ton Westinghouse Baldwin trolley; one 3-ton Westinghouse Baldwin battery; one 8-ton GE (25 years old); one 8-ton GE (w/o big battery); and three 8-ton Atlas.

All power used in the mine is either electrical or compressed air.

Some of the ore cars are equipped with Jones & Laughlin manganese-molybdenum steel bottoms — a case of moly hauling moly.

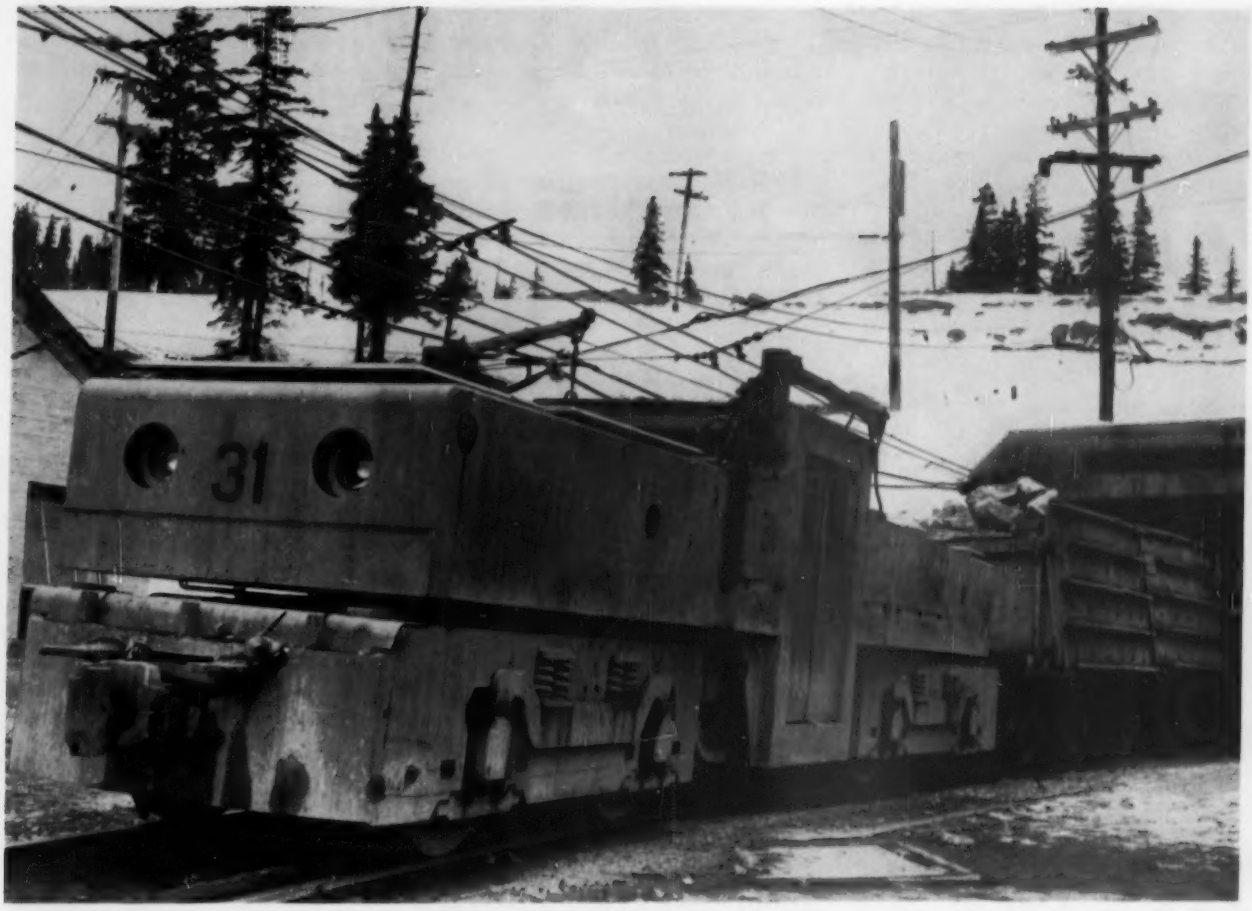
AT THE CRUSHER: Carloads of ore-bearing rock from the Storke level are hauled to the crusher and their contents dumped into a giant Nordberg Symons gyratory unit. Crushing operations reduce the ore to minus 8 in. in size.

Crushing the Ore

Moly also crushes moly, the primary crusher containing molybdenum. The crusher, which handles the flow of ore from the Storke level, is a 60-in. Nordberg Symons gyratory with an ultimate capacity of 2,500 tons an hr. Weighing 500 tons, it is one of the largest Nordberg has ever built — about as tall as a four-story schoolhouse. Powered by a 500-hp. electric motor and worked by eccentric gears, a 95-ton bell-shaped mantle revolves and swings at the same time inside a bottlelike structure of steel. The crusher reduces the ore to less than 8 in. From the crusher, the ore is transported on a 60-in. conveyor belt that travels 350 ft. a min. to bins that are 46 ft. high and 100 ft. in diameter at the bottom, each of 3,000-ton capacity. From the bins, the ore follows a conveyor course through screening and secondary crushing — a Nordberg Symons cone. Before the initial separation of moly sulfide by flotation, the ore is reduced to less than 1/30 in.

Tailings are piped as slurry to a pond three miles north of Climax. The tailings pond covers the site of the early-day boom mining town of Robinson, once sufficiently in the chips to have a smelter. A great deal of water is drawn off for reuse in the mill. Fourteen million gallons of water are cycled through the mill every 24 hrs.

There's an engaging thing about the older tailings pond at Climax. At present, a part of the expanded village is located on the old pond. It is known that the pond contains at least a million dollars worth of tungsten. For years, the Climax organization did not recover the tungsten appearing in the Bartlett Mountain ore. During World War II, when tungsten was in great



EXTENSIVE RAILROAD FACILITIES: The railroad facilities at Climax include 6½ miles in the Phillipson level, 3½ miles in the Storke level, and 2½ miles on the surface.

demand, Climax started recovering it. If any one is prospecting for million-dollar trove of tungsten, he can find it at Climax.

Mill Production

The milling also recovers iron pyrite, wolframite, and tin. Although the tin tonnage is negligible, Climax is considered the largest tin mine in this country.

However, the real end product is molybdenum concentrate, and it trickles out of the pay-off spigot at the rate of 6 lb. per ton of ore. The present production rate of concentrate is 42,500,000 lb. a year, well over half the output of the United States. Production elsewhere is at Kennecott Copper Corporation's activities in Utah, where moly is a by-product, and from smaller operations in the West.

Climax is one of the world's large users of wooden barrels. The company spends very close to a million dollars a year for these containers in which some moly concentrate is shipped. Other concentrate is shipped to the Climax conversion plant at Langeloth, Pennsylvania. There, by a process including roasting, the concentrate is converted into technical molybdic oxide. A thermite process at this plant also turns out ferromolybdenum. A metal known as thermite moly, which contains more than 95 per cent molybdenum, is also processed at the Langeloth plant. Other alloys include moly-silicide, nickel, cobalt-moly, and pure moly oxide for the chemical industry.

Molybdenum's Versatility

It is not the volume but the versatility of moly that makes it great. It is used in the manufacture of nearly everything from jet engines to beer cans. You will find none of this precious stuff in a beer can, but manufacturers of cans with conical tops have learned that a die greased with moly punches out the tops without scratching. Although moly is generally considered a steel toughener, it has achieved spectacular success as a lubricant for delicate mechanisms as well as for the biggest industrial bearings.

Around 60 per cent of the moly produced goes into steel for automobiles, machine tools, welding rods, tractors, farm machinery, and heavy industrial equipment. The second largest consumer is the oil industry for its pipe, tubing, kelly bars, sucker rods, drill collars, tool bits, and the like.

United States Steel Corporation recently announced a new moly alloy called USS Carilloy T-1 steel. It was developed to meet the need for a steel, mainly in plate form, having an extremely high yield strength (90,000 p.s.i or more), yet tough enough to withstand exceptional stress and pressure as well as shock at high or low

temperatures. The steel is weldable and is easily fabricated. It has approximately three times the yield strength of ordinary steel; it is tough and resists impact, abuse, and abrasion.

Moly reduces wear to the vanishing point and virtually eliminates the fatigue factor. It breaks when subjected to severe stress at room temperature, but it won't melt until the temperature hits 4769 degrees F., a melting point exceeded only by tungsten and above which all the rocks of the earth would become molten. Molysteel is used to make super-tough tools, armor plate, gun barrels. In a future war, moly could be a decisive factor. For this reason, the United States Government is stockpiling all it can get. Uncle Sam keeps a steady eye on the Climax works; plant security, almost equal to wartime precautions, is approved by the Government. So it is that Moly Mountain is one of the world's most important peaks.

Personnel

Climax Uranium Company, a subsidiary of the parent organization, is engaged in exploration and mining on the Colorado Plateau. The capacity of its mill at Grand Junction, Colorado, has been doubled in recent months. The Climax Oil Department has considerable holdings in the Southwest, and, not long ago, added large oil and natural gas properties in Oklahoma and Texas.

The executive headquarters of Climax Molybdenum Company are in New York City. The officers and department heads include Arthur H. Bunker, president; Weston Thomas, executive vice president; R. E. Warriner, vice president in charge of sales; Lamar Kelley, director of public relations; Frank Coolbaugh, vice president of Western operations and president of Climax Uranium Company; Alvin J. Herzig, vice president in charge of research; Robert Archer, chief metallurgist; Wallace Macgregor, treasurer; and Lester Cowan, secretary.

Robert Henderson is resident manager of the Climax operations. Operating details are supervised by E. J. Eisenach, assistant general superintendent; W. H. Wilson, controller; J. M. Petty, mine superintendent; C. A. Cleeves and J. Johnson, general mine foremen; Cecil Smith, master mechanic; Max Dessau, mill superintendent; and M. S. Walker, chief engineer. W. E. Jones is director of Industrial Relations and Gordon Weller directs the work of the Public Relations Department, which publishes the community biweekly newspaper, *The Moly Mountain News*.

On the Human Side

On the human side, Climax has some activities peculiar to the one company. Its ownership of the town scattered about the ramparts of the Rockies on a 4,500-acre estate gives it quite a few things to think about. The company operates the fire and police departments; it pays the town's taxes and 70 per cent of the taxes in Lake County, of which once-illustrious Leadville is the county seat. Climax is a little alpine world in itself; it is a complete community but it has no bank. The town's banking business is transacted at Leadville. The county seat also has the main hospital facilities and is building a larger hospital to which Climax Molybdenum contributed $50,000. However, Climax does have a smaller hospital, which is owned and run by the company.

In the annals of mining in the West, many companies have owned the town or community hard by their diggings; others have operated on the commis-

MODERN APARTMENTS: Among the many improvements included in its recent expansion program, Climax built 10 modern apartment buildings for employes. A two-bedroom apartment, with heat, costs $46 a month.

FOR THE CHILDREN: With every desk occupied in the company's elementary school at Climax, children pursue the age-old curriculum of reading, writing, and arithmetic.

sary system. But still it is different with Climax, which has a population of 2,500.

Climax has more problems with snow than perhaps any other company-owned municipality. The community is relatively isolated, especially in the winters. Although Moly Mountain is an old mining operation, Climax is on the youthful side. Of the 1,400 company employes, more than 400 are in the 30 to 40 age group. Nearly 600 others are under 30.

The winter heat bill for dwellings, offices, and other surface installations is close to $200,000. It costs $35,000 a year to heat ten big apartment buildings which are occupied by employes. In its recent expansion program, the company paid $15,000 to keep snow removed from the building site of a mill. Snow crews work almost full time in clearing driveways, pulling out stuck automobiles, keeping the roads open, and in clearing the trackage of the Colorado & Southern Railway which bought out the pioneer line that topped Fremont Pass so long ago. The fighting of snow costs Climax one-quarter of a million dollars a year.

One of the favorite winter stories one hears at Climax is that of a man who moved to Moly Mountain from Georgia, arriving there in June. In September he wrote home that "a beautiful snow has transformed Climax into a brilliant white fairyland." The next month he wrote that "more of the wonderful snow has fallen softly down." In a letter home the following January he reported to the home folks: "Another snow this week; you never saw so much of the damned stuff."

There are many problems in any operation and the company is studying and acting on these problems as quickly as possible. A highly mechanized mine and mill operation, like Climax, fares much better with stable, long-time employes than with itinerants. Employe turnover hurts the efficiency and safety of operations and, of course, the production.

"Design for Man" Program

Because it did have a high turnover rate for years, Climax decided to improve and modernize living conditions in an effort to stabilize labor. President Bunker called the program a "Design for Man." He added: "This program contemplates the design for a comfortable home, recreation, a full paycheck,

Arthur H. Bunker, president of Climax Molybdenum Company.

physical safety and health, a good hospital, a modern school, and many of the other satisfactions of living, including television."

Being situated in a valley at the top of the continent, Climax had no television reception. Many employes wanted it. Some who could get jobs elsewhere left Climax because of the lack of TV, or possibly a combination of this and other problems. The company met this by building the world's highest television aerial, located on the windswept summit of McNamee Peak. From this tower, TV programs are cabled into every home in Climax. Reception from Denver stations, which transmit from atop Lookout Mountain above Golden, is as good in Climax as it is in Denver.

For the entertainment and contentment of employes, Climax has done numerous other things. The Climax Recreational Hall has bowling alleys, billiard rooms, a shooting gallery, a library and reading room, TV rooms, meeting rooms, and a large gymnasium.

Some years ago, the company built a T-bar ski lift on Chalk Mountain,

Weston Thomas, executive vice president.

Frank Coolbaugh, vice president, Western operations.

Robert Henderson, resident manager.

DAY'S WORK DONE: At the end of a shift, Climax Molybdenum's workers lose no time in getting to their attractive homes and living quarters. Of the company's 1,400 employes, 625 work underground.

just west of the village. In the winter season it is open several days and two nights a week. It is operated by the Continental Ski Club. The town's movie house has shows three nights weekly. The community newspaper, *The Moly Mountain News*, is published by the company biweekly. It contains company and community news.

In its recent expansion program, Climax paid as much attention to the "Design for Man" as it did to the business of producing more moly. It built 70 three-bedroom homes and 10 apartment buildings with 180 four-room apartments; a combination gymnasium and auditorium for the school that seats 800 for basketball and 1,200 for auditorium purposes; added an annex to the hotel providing rooms for 68 men and bringing the total rooms to 300, all for men; provided a shopping center, operated on a lease basis; built eight new rooms to the hospital; and added to the school building by expanding the shop, the library, and many of the classrooms.

The ownership of the various enterprises in the village does not mean profit for the company. Home-building costs at Climax are 150 per cent higher than at Denver. Yet a three-bedroom home rents to employes for $42.50 a month. A two-bedroom apartment, with heat furnished, costs $46 monthly. Men employes who live at the hotel get lodging and meals, including lunches, at $3 a day.

Climax has 24-hour-duty police and fire departments. The village has practically no crime and no snakes. Houseflies are scarce and hay fever is very rarely experienced. The community has a very low divorce rate — wives are particularly treasured in Climax.

There are no traffic snarls. Peddlers and solicitors are not allowed entrance. No liquor is sold on the company's reservation.

In summing up the natural attractions of the high climate and the things the company has done for the well-being and contentment of employes, Resident Manager Henderson said that employe turnover has been reduced to a figure comparable to that in the mining industry at lower elevations. Working conditions and the size of the paychecks have something to do with this. The average pay of hourly wage earners runs about $16.40 a day. There is a pay differential between underground and surface work. Likewise, a man working underground where it is wet overhead receives an additional premium.

The mine-mill operation has a safety record of significance. Every day Tom Hoy, head of the Safety Department, preaches common-sense practices. Over the years, the safety record has shown substantial improvement; and it is the desire of everyone connected with the operation to make Climax the safest mining operation in the world.

During the past 38 years—from 1917 to 1955—Climax has not lost a man-hour because of a labor dispute. Employes are members of the Climax Molybdenum Workers Union, Local No. 24410, American Federation of Labor.

From almost any point in Climax, or from Fremont Pass, the people can glance over at the dark hulk of once-bleak Bartlett Mountain. With only a touch of imagination, they can see the glory hole getting bigger and bigger and sinking deeper and deeper—the result of blasting the ore in the innards of the peak.

JEFFERSON ISLAND

SALT COMPANY'S MINE IN LOUISIANA

Using the room-and-pillar method of mining in a cigar-shaped pillar of salt 1,000 feet under the surface, some high-roof operations leave rooms 100 feet high

DON MACON*

JEFFERSON AS RIP: Joseph Jefferson, one of the theater's immortals, as he appeared in his world-famous role of Rip van Winkle.

JOSEPH JEFFERSON was a famous actor and artist of the mid-nineteenth century. By 1870, the clamor of his admiring public led him to seek a hideaway where he might pursue the more peaceful pleasures of privacy. He found his "Shangri-La" atop a knob of land rising out of the flat coastal plain of Louisiana. Here beneath the giant live oaks he built a mansion of native cypress, planted flowers and prepared to enjoy his luxurious solitude. But Jefferson's hideaway lacked one thing — good water.

Mr. Jefferson called in a man by the name of Lucas who was known to be handy with cable tools. Some 30 years later this same skill, whetted by the tenacity that stems from the rich smell of crude oil, skyrocketed Captain Lucas to fame, for it was he who brought in the first big gusher at Spindletop, near Beaumont, Texas.

Whether or not the dogged Captain had grown accustomed to the disappointment of occasional drilling failures as early as the 1870's is not known. At any rate, his work on Jefferson Island yielded only salt water. However, he made a discovery that was not to be fully realized until a half century later.

Today, we know that Joseph Jefferson built his mansion upon a tract of land that had bulged upward far back

*Texas Industrial Film Company
2528 North Boulevard
Houston, Texas

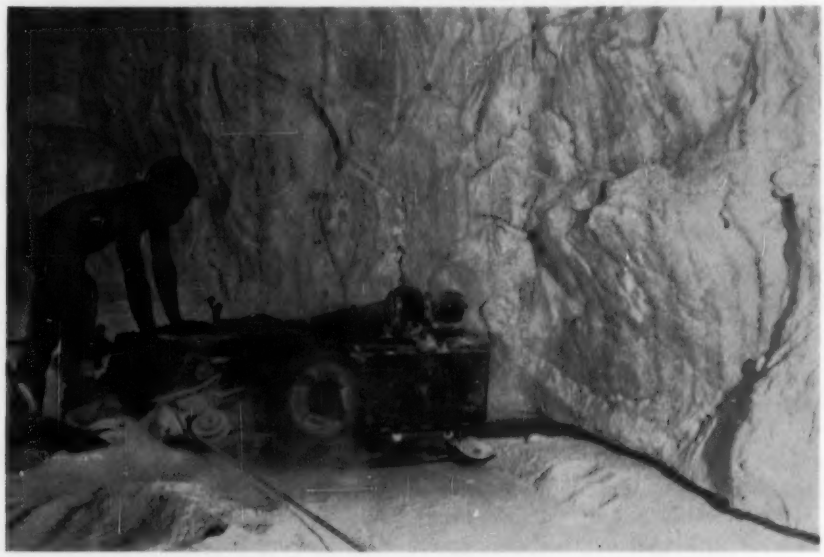
in geological history when a huge finger of salt protruded from its mother bed 25,000 ft. below to grow to a peak just 62 ft. below the earth's surface. Shaped like a cigar, this underground tower of salt is roughly 1¼ miles in diameter. It yields a mine-run product of better than 99.0 per cent purity.

Room-and-Pillar Mining

Current mining operations stem from the purchase of the Jefferson tract in 1917 by Bayless and Jones who farmed the plantation, growing rice and sugar cane. In spare time the new owners probed the possibilities of the salt dome below. They found a location where the salt was accessible and, in 1920, sunk a shaft 100 ft. in circumference. From the surface to the salt, the shaft was lined with reinforced concrete. At first, salt water leaked in between the concrete and the formation but it was successfully sealed off with asphalt. The shaft sinking was continued down through rock salt to a working level at 1,000 ft., where the salt is purer than closer to the surface. A four-compartment shaft encloses an air duct, a man cage, and two skips, each skip having a capacity of 5 tons.

Bigness has new meaning 1,000 ft. down in a mushroom of salt. As one walks through galleries formed by rooms and pillars, each 70 ft. square, there is no feeling of being crowded. In the new development, 24-ft. ceilings carry out this theme of bigness effectively. But when one moves into areas where high-roof operations have left ceilings 100 ft. high, the underground immensity becomes inspiring.

In the mining operations in the new development, a face 24 ft. by 70 ft. is undercut 8½ ft. deep, leaving a 6-in. kerf. The job is done with a Goodman electric chain tooth undercutter with a cutter bar 9½ ft. long.



UNDERCUTTING: In the new development, a 24 by 70-ft. face is undercut 8½ ft. deep with a Goodman electric chain tooth machine, leaving a 6-in. kerf.

DRILLING: For blasting in a face, Scranton electric drills and auger steels are used to drill 128 holes, 8½ to 9 ft. deep, in horizontal rows.

Drilling and Blasting

A total of 128 holes is drilled into the face with four Scranton electric drills using 220 volts D.C. Equipped with 1⅛-in. auger steels 14 ft. long, the drills are mounted on a jumbo built by Joplin Iron Works. There are seven horizontal rows of drill holes with 24 holes in the top and bottom rows and 16 holes in the remaining five rows. All are drilled to a depth of 8½ to 9 ft.

The method of loading the explosives charges is the same for all holes: two cartridges of dynamite are loaded and tamped, then the primed cartridge goes in, after which the remainder of the charge is loaded and tamped.

Using 1¼ by 8-in. cartridges exclusively, 12 cartridges of Hercomite® 2-X are loaded in the rib holes, 12 cartridges of Hercomite 4-X in the top and bottom rows, and 10 cartridges of Hercomite 4-X are loaded into the remaining holes. The dynamite charges are primed with electric blasting caps and short-period delay caps, used in combination. This insures the order of firing the charges to progress from the bottom upward. The caps are equipped with aluminum shells and iron leg wires — a special design for purposes of maintaining purity of the salt. During processing, iron particles are readily picked up by electromagnets.

The leg wires of the caps in each row of holes are connected in series; the rows are connected in parallel.

PREPARING TO BLAST: Each drill hole is loaded with Hercomite dynamite.

LOADING OUT: After blasting, Bucyrus-Erie electric shovels are used to excavate the broken salt and load it into 5-cu. yd. Koehring Dumptors.

Blasts are fired with a 440-volt A.C. shooting line. Blasting is done generally at the end of the second shift each day.

For each 24 by 70-ft. face, a total of 500 lb. of Hercomite is used to pull about 8 ft. of salt. Mine officials estimate 850 tons of salt per blast, an explosives loading factor of 1.7 tons of salt per 1 lb. of dynamite.

Loading Out the Salt

Clean-up around a muck pile is done with an Allis-Chalmers HD5 crawler tractor equipped with a 1-cu. yd. front-end loader. Three Bucyrus-Erie electric shovels are used for all loading — two with ¾-cu. yd.-capacity dippers, the other a 1½-cu. yd. dipper. Koehring Dumptors, each 5-cu. yd. capacity, haul all blasted salt to the base of the shaft, where it is crushed and moved to the top in the two 5-ton skips. The hoisting capacity per 8-hour shift is 2,250 tons of mine-run product.

A sizable reserve of blasted salt is maintained by high-roof operations which continue uninterruptedly. Three overhead benches are carried, each 70 ft. wide and 24 ft. thick. The lowest bench advances 70 ft. ahead of the middle bench which, in turn, advances the same distance ahead of the top bench.

Drilling is different here from that in the new development. A single drill is used, the same make and size as previously described. It is mounted on a vertical 4-in. pipe column which is supported by a screw jack at the bottom. The jack, resting on the muck pile, is adjusted to raise the column against the roof with enough force to hold it securely. An A frame is attached to the column to form a vertical support for the end of a ladder extending out from a higher portion of the

BLASTING RESULTS: A primary blast of 500 lb. of Hercomite pulls about 8 ft. of face. This represents an average yield of 850 lb. of salt per blast.

PROCESSING PLANT: Following a fire in 1940, the processing plant was rebuilt. It combines modern design and equipment.

muck pile. This serves as a working platform for the driller, placing him opposite the face.

The drill is hoisted with a block and tackle and mounted on the vertical column in a manner that allows it to pivot horizontally. Five holes or more are drilled from one position. Five set-ups of the column are required to drill each face. Two rib holes are drilled in each end and three sets of five holes each are spaced across the remainder of the face. In the five-hole groups, the center hole is drilled straight in, with the two holes on each side fanning out from the pivot point like spokes in a wheel.

The holes are drilled into the face of each bench to a depth of 10 ft. The loading of explosives charges involves the same method used in the new development, and each blast pulls about 9½ ft. of salt. When the third, or top, bench has been blasted, a muck pile 80 ft. high is realized. Recovery of the blasted salt is accomplished with the Bucyrus-Erie electric shovels. The 5-cu. yd. Koehring Dumptors haul the blasted salt to the shaft for crushing and hoisting to the surface.

Diversified Users

The processing of the mined salt at Jefferson Island is a complete and interesting story itself and should be described at another time. However, we were impressed with the fact that only a tiny percentage of the production goes into table salt. Actually, the big deliveries are made to widely diversified industries ranging from chemical users through paper mills, meat preservers, pickle canners, ice plants, water softeners, and to farms for use in feed mixes and salt blocks.

Jefferson Island Salt Company, with headquarters in Louisville, Kentucky, is actively headed by J. L. Bayless, Jr., president, with E. M. Dodd, vice president, in charge of production. As of January 1, 1955, R. D. Rudolph is works manager at the mine and plant, replacing F. W. Wright, retired.

The tremendous galleries blasted from pure rock salt 1,000 ft. underground at Jefferson Island will bear description to family and friends for a long time to come. The plant is also impressive. Completely rebuilt after a totally destructive fire in 1940, it's the last word in modern design and equipment. Were it not for the beautiful white mansion near the plant entrance, still splendid beneath the giant live oak trees, it would be difficult to imagine this industrial setting as once having been the hideaway of world-famous Joseph Jefferson.

WORKS MANAGER: All operations in Jefferson Island Salt Company's mine and plant are under the supervision of Works Manager R. D. Rudolph.

Well-Drill Blasting On a New Hampshire Road Job

DEEP, WIDE ROCK CUT: On this section of the new turnpike looking north toward Manchester, New Hampshire, a hill of hard, seamy granite was blasted with 9-in.-diameter well-drill holes.

Using 9-in.-diameter well-drill holes, contractor blasts a hill of granite 1,200 ft. long, 125 ft. wide, and 63 ft. deep

Along with many other states, post-war New Hampshire found that mounting vehicular traffic on its highways and streets created problems that required solutions by state, city, and town officials. One of the most serious trouble spots demanding immediate attention by highway officials was a 40-mile section on U. S. Route 3 between the State capital of Concord and the borderline of the neighboring State of Massachusetts.

As part of New Hampshire's road-construction program, a section of a new turnpike, the F. E. Everett Turnpike, was begun in Merrimack, a half-way point between Manchester and Nashua, and progressed both north and south from that point. Manchester Sand, Gravel & Cement Co., Inc., of Hookset, New Hampshire, was awarded the contract for the work on this section of the new highway.

Included in the contract specifications was the removal from the right-of-way of a hill of approximately 156,000 cu. yd. of hard, seamy granite 1,200 ft. long, 125 ft. wide, and a varying depth of 20 to 63 ft. This part of the contract was sublet to the firm of

U. O. MacDonald, East Braintree, Massachusetts.

Drilling and Blasting

Despite the proximity of overhead power lines, the MacDonald firm decided to blast the hill to its full depth in a series of well-drill hole blasts. Using 9-in.-diameter well drills, the holes were drilled to an average depth of 58 ft., centered on 20-ft. spacings. The holes were loaded with 11,500 lb. of Gelamite®-D in 8½ by 50-lb. cartridges and divided into two rows of six holes each. Each hole was double primed with Hercules® Short-Period Delay Electric Blasting Caps from "0" to "4" and stemmed to the collar with an average of 20 ft. of sand.

The MacDonald subcontract stipulated that he furnish broken rock in sufficient quantity to keep two 1½-cu. yd. power shovels, an L80 Loraine and a Model 6 Northwest, working uninterruptedly side by side. Other specifications in the subcontract called for a minimum of overbreakage, no secondary blasting, the bunching of broken material, and no interruption in public utility service.

Excellent Results

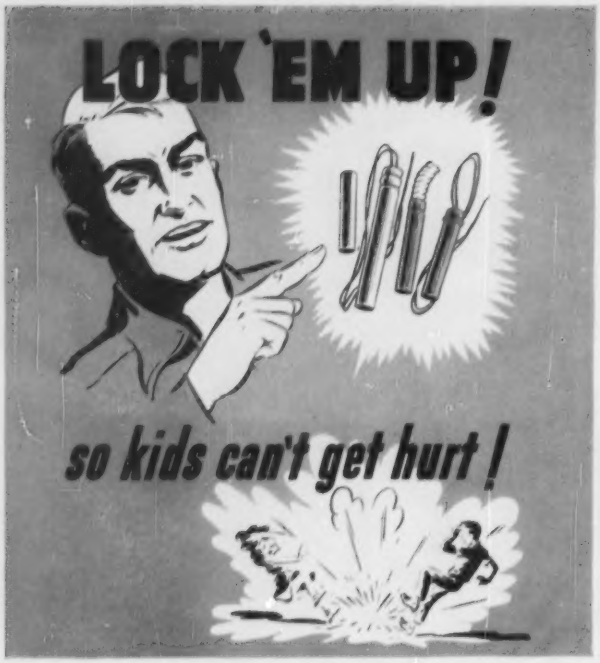
The results of the blasts were excellent and no secondary blasting was required. The prime contractor, Manchester Sand, Gravel & Cement Co., Inc., excavated 280 to 300 cu. yd. of blasted granite an hour and placed it along the bank of the Merrimack River as slope protection for the through-pass construction.

In commenting on the unusually successful blasting results, C. J. Downing, turnpike construction engineer for the State of New Hampshire, paid tribute to U. O. MacDonald. Mr. Downing said that, to his knowledge, this was the first time 9-in. well drills had been employed within his state on any highway construction work.

LOADING THE DYNAMITE: The holes were drilled to an average depth of 58 ft. and loaded with Gelamite-D in 8½ by 50-lb. cartridges. Contractor U. O. MacDonald, holding the tape, supervises the operation.

THE BLAST: The hill was blasted in a series of well-drill hole blasts to its full depth. A total of 11,500 lb. of Gelamite-D was required to reduce the hill of granite to grade level.

EASY DIGGING: Fragmentation was excellent and no secondary blasting was required. The broken rock settled in a sloping bank down the middle of the roadway within easy reach of the power shovels.



Lock Up Those Blasting Caps

The Institute of Makers of Explosives introduces a new phase of a 27-year safety campaign to eliminate accidents to children from playing with blasting caps

For almost 30 years, the Institute of Makers of Explosives, an association of explosives manufacturers in the United States, has carried on a campaign to promote the education of the nation's children, their parents, and adult supervisors in the dangers of playing or tinkering with blasting caps.

Using motion picture films, posters, leaflets, and special display boards with dummy blasting caps attached, the Institute has received the wholehearted support of police and fire bureaus, schools, the Boy Scouts, boards of health and safety councils, radio stations, newspapers, magazines, trade journals, various branches of the Federal Government, and many organizations interested in child welfare. The cooperation of these groups with the Institute's efforts has been magnificent.

Far-Reaching Program

Even though this safety program has been far reaching and splendidly supported, blasting cap accidents to children last year numbered 190, an increase of 58 over the 1953 figure. While the number is small as compared with the total number of all types of accidents to children each year, all of the 190 accidents could have been avoided if every user of explosives had exercised proper care in preventing these detonators from getting into the hands of children.

The increase in the number of accidents during 1954 is accounted for, to some extent, by the increase in the number of children throughout the nation. The higher accident rate has resulted in even more extensive work by the Institute's public relations committee, in its efforts to reduce blasting cap accidents among our boys and girls.

Direct Appeals to Users

Recently, the Institute introduced a new phase of its safety education program by making appeals direct to all users of industrial explosives for more thorough-going cooperation. Sales organizations of explosives manufacturers are distributing especially prepared posters and pamphlets throughout the country urging miners, quarrymen, contractors, and farmers to keep track of their caps and keep them out of the hands of our country's youth. "Don't gamble with children's safety," the Institute's pamphlet warns. "You know that blasting caps are dangerous but children don't. Lock 'em up so kids can't get hurt."

You Can Help

Every user of explosives knows that blasting caps, both fuse and electric, make dangerous playthings. But it is almost impossible to impress this fact on every child's mind. No matter how thoroughly safety is learned at school or at home, the youngsters forget in the excitement of play.

Since 1927, the number of accidents has been materially reduced. Much of the credit goes to users of blasting caps who, each year, are more careful in storing, handling, and using them. But a little more thought and care on the part of all users of explosives will reduce even further the tragic crippling of children. And there will be no letup in the crusade by the Institute until all accidents from this cause are entirely eliminated.

INGENIOUS BLASTING TECHNIQUE SAVES A MILLION DOLLARS

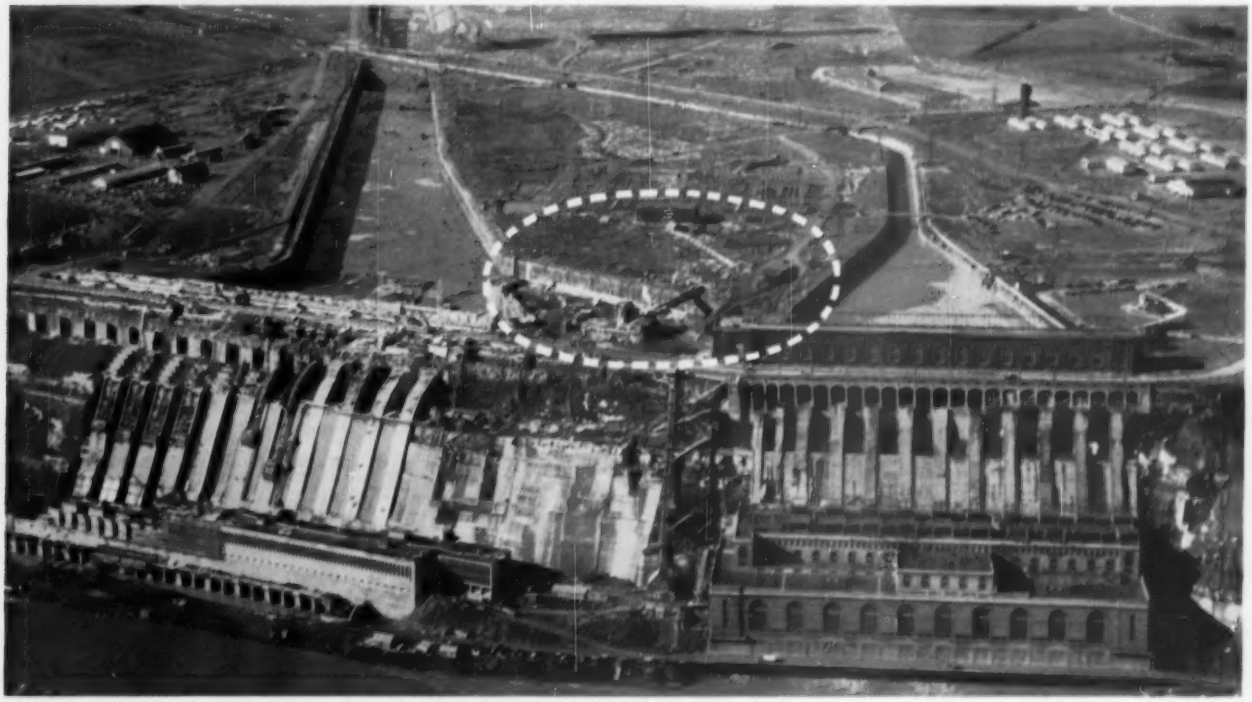
Shock waves from a 12,000-lb. blast in rock only 85 yd. from an electric power generating station were absorbed by a curtain of compressed-air bubbles in water

THE construction of a 1,828,000-hp. generating station at Queenston, Canada, 6 miles below Niagara Falls, presented a difficult blasting problem to the engineers of the Hydro Electric Power Commission of Ontario. A 12,000-cu. yd. ledge of rock in the forebay area of an existing 550,000-hp. generating station, designated Station No. 1 and located only 85 yd. away from the rock, had to be removed so that the water in its forebay would connect with the water in the forebay of the new generating station.

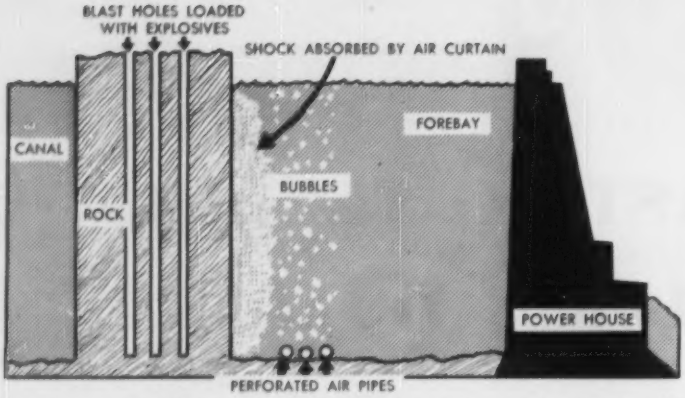
The Commission's engineers had considered draining the water in the forebay of Station No. 1 and removing the rock by a succession of relatively small blasts "in the dry." The adoption of this plan would have meant the closing down of the ten generators in Station No. 1 and the purchase of power requirements from United States' sources at a cost of approximately a million dollars.

Unique Idea

While the problem was under study, "Lap" LaPrairie, a Canadian explosives engineer, suggested to the Hydro engineers the placing of a curtain of compressed-air bubbles in the water of the forebay to absorb the shock waves



ROCK REMOVAL PROBLEM: The circled section indicates the critical area of the blast. The rock between the two forebays was removed by blasting, without damage to nearby structures.



CROSS SECTION: The compressed-air curtain in cross section.

from the detonation of a blast in the rock deposit. His unique idea was to connect a 6-in. air line to three 3-in. pipes clamped together in a fixed position in the water, spaced on 9-in. centers. The complete unit was to be submerged on the bed of the forebay between the ledge of rock and the headworks of No. 1 generating station. This suggestion appealed to the engineers, and a series of tests were conducted in a tank of water, bisected by pipes through which compressed air was forced. After two months of experiments, the desirable quantity of air and the size of bubbles were determined. The Commission approved the use of the ingenious blasting technique and work details were started at the project site.

Operation Air Bubbles

After the air line was installed, the pipe-line assembly was submerged in the water in the forebay between the ledge of rock and the headworks of the No. 1 generating station. Each pipe was perforated with 36 small holes per foot.

Compressed air under 90-lb. pressure was forced into the pipes; 3,750 cu. ft. of free air were pumped in each minute. The air bubbles from the piping raised the surface of the water 4 ft. above normal. Holes were drilled into the rock formation and each hole was loaded with explosives and primed with short-period delay electric detonators. The total explosives used in the blast amounted to 12,000 lb. As an added protective measure, Hydro workmen sandbagged the headworks of the generating station.

Results from the blast came up to expectations in every detail. The blast satisfactorily removed the ledge of rock, and the vibrations that reached the generating station were only 1/70 of the amount that would have been produced without the air curtain.

The air-curtain part of this unique blasting procedure cost about $2,000. Its use saved the Hydro Electric Power Commission an estimated $1 million by averting a shutdown of the ten generators in Station No. 1.

EAR-VALV SOLVES NOISE PROBLEMS

The Lee Sonic Ear-Valv, a very small mechanism which is contained in the ear by a silicone rubber ear-insert, offers a new and different approach to the solution of the industrial noise problem. It automatically damps out vibrations above the average human tolerance.

Manufactured by Sigma Engineering Company, 1491 North Vine Street, Hollywood 28, California, a set of two

has 18 precision, watchlike parts made on the finest Swiss tooling machines and completely assembled by hand. It fits the ear canal almost unnoticed.

Literature available from the manufacturer explains in detail how the valve mechanism dissipates the harmful energy of high sound pressures, whether they be of a transient nature, such as high explosives, or of a constant nature like jet engines. While the device is dissipating the harmful energy, the "wave form" or intelligence component of the ambient sound passes through the valve unaltered.

In the instance of high-pressure levels of a transient nature, such as gunfire or explosives, the valve within the mechanism reaches complete closure against both concussion and repercussion, thus assuring that the ear drum will not be injured.

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To lengthen a Trunk Line of Plain or Reinforced Primacord, tie a SQUARE KNOT. *Draw it up as tight as you can* — it won't slip back. Caution: don't use any knot in a hole — it might break or hang up explosives when loading.

PLAN GOOD DIGGING *by using* PRIMACORD

As every blaster knows, good digging begins with good planning of the blast.

Primacord is recognized as the safest and most convenient method of firing blasts.

As the detonating agent in each hole it produces continuous priming along the borehole and tends to speed up detonation of the charge — develops more work from the explosives.

As the trunk line, it connects all holes and enables the Blaster to plan the shots for proper sequence, with respect to the open face or the most logical direction of movement of the bank. And, while Primacord detonates at a speed of nearly four miles per second, the infinitely small time delay between holes and rows of holes has been sufficient to relieve burden and produce better fragmentation.

Primacord is light in weight, flexible, strong. It is easily hooked up as shown here. And it's available in Plain, Reinforced, Wire Countered and Plastic Reinforced — each designed to give you the best results under certain conditions of service.

For more information see your Explosives Supplier, or write to

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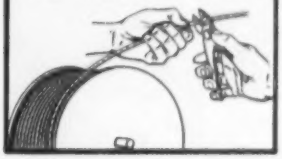
Primacord — Quarrycord — Ignitacord® — Safety Fuse Blasting Accessories — Established 1836

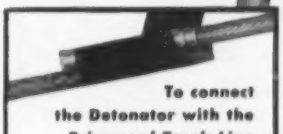
Cut the Primacord off the Spool Immediately

Make this a safety habit! As soon as you have taken off the length of Primacord you need for a down-hole or for a trunk-line, *cut it off the spool! Don't waste a second — do it now!*



To connect a Branch Line of Plastic Reinforced or Plastic Wire Countered Primacord with the Trunk Line

use this DOUBLE HITCH in the textile-covered Primacord Trunk Line. *Draw it up as tight as you can, and make sure that the Branch Line leads off at a RIGHT ANGLE to the Trunk Line.*



To connect the Detonator with the Primacord Trunk Line

use FRICTION TAPE. You can detonate Primacord with fuse and cap or electric blasting cap. Lay the cap alongside of the Primacord with the business end of the cap pointing in the direction that the Primacord will detonate. Tape the two snugly together, so that you have a tight connection.

To connect a Branch Line with the Trunk Line

Use this HALF HITCH for Plain and Reinforced Primacord. *Draw it up as tight as you can, and be sure the Branch Line leads off at a RIGHT ANGLE to the Trunk Line.*

PRIMACORD®

DETONATING FUSE

PROVED AND APPROVED

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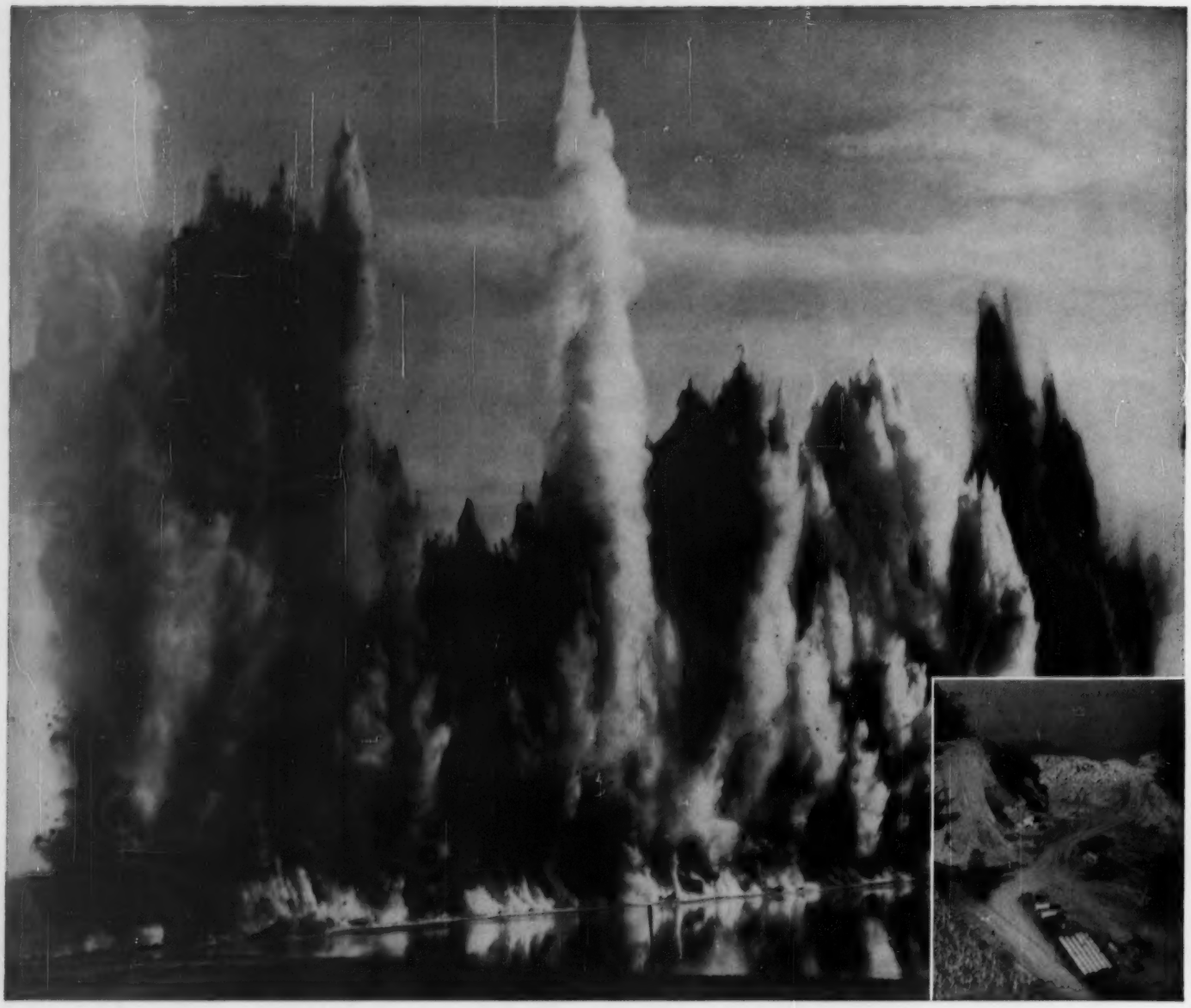

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explosives research pays off

The tremendous power of dynamite, skillfully and ingeniously handled, made it economically possible to cross the wide, deep Tennessee River (inset above) with two parallel pipelines, 50 feet apart. Trenches blasted underwater through hard red clay in the shallows, and lime rock in the 40-foot-deep channel, opened the way for speedy dredging operations . . . another example of the efficiency of modern explosives and blasting methods.

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Explosives Department

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- Rugged, heavy-duty chain-feed assembly and feed motor provide plenty of power for the hardest lifts.
- Weight distribution planned for best maneuverability and stability.
- Accurate two-way control of U-arm makes for easy positioning under any conditions. Easy to position for line drilling against walls and faces. Swivel rear wheels help quick, easy line drilling.
- U-arm can be lowered to ground level for lifter holes.
- Wagon frame and U-arm are heavy steel tubing with forged fittings — damageproof against on-the-job hazards.

For more information on Blue Brute wagon drills, see your Worthington distributor. Or write to Worthington Corporation, Portable Compressor and Contractor's Tool Division, Section H.5.2, Holyoke, Mass. H.5.2

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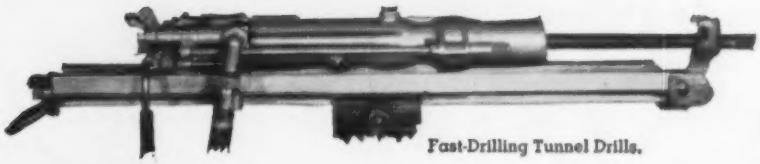

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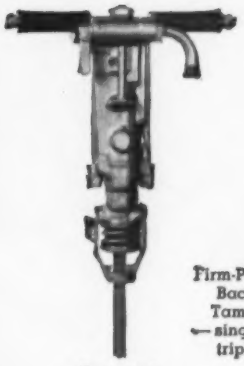

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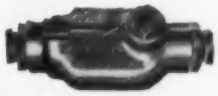

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